

Association of positive and negative life events with cognitive performance and psychological status in late life: A cross-sectional study in Northern Portugal

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ABSTRACT

Objectives: Life events have important effects on psychological well-being. Yet, studies have mainly focused on exploring the impact of traumatic and negative experiences on health and well-being, with positive events receiving marginal attention. In this study, we investigated the association between negative and positive life events, cognitive performance and psychological status in older individuals.

Method: A cross-sectional approach with a sample of 97 community-dwelling adults, recruited from a network of 23 centres/institutions in Northern Portugal, and aged between 56 and 85 years, was conducted. All participants were evaluated through a battery of tests assessing for depressive mood, perceived stress, and cognitive functioning. Life events were measured using the Lifetime Experiences Scale (LIFES) which covers 75 life experiences organized in eight domains.

Results: A total of 95.9% of the participants reported more positive life events than negative throughout life. Participants reporting more positive experiences had lower scores in the depressive mood and perceived stress measures. At the domain-level of LIFES scale, more negative experiences in the Work and Health domains were associated with a depressed mood and more perceived stress. Significant positive associations were found between positive life experiences and most cognitive measures, after controlling for sex, education, age and depressive symptoms. Namely, more positive experiences at School, Leisure, and Living conditions were positively associated with better performance across cognitive tests.

Discussion: This study adds important evidence on the association between of life events, both negative and positive experiences, on cognition and psychological well-being, providing a more balanced view of the field.

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Introduction

Preserving cognitive function and maintaining psychological well-being across ageing is of great importance.

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Psychological well-being refers to the individual's ability to have a positive outlook on him/herself and life, a sense of mastery, purpose, the meaning of life and autonomy, positive relationships, and continued development in old age [32]. Much of the general view in late life can be determined by a series of events, starting with the ones that date back to childhood and culminating with recent ones. Life events, defined as experiences that can disrupt an individual's usual activities and prompt a substantial change and adjustment to habitual life, have been considered crucial determinants of older adults' physical and mental health [13]. They also can influence the assessment that people make of their current life [39], with a relevant impact on psychological well-being.

Notably, however, research has mainly focused on exploring how traumatic and negative experiences can impact, and/or have a deteriorating effect, on health and psychological well-being. For instance, studies on the accumulated effects of negative life events have found that older people who lost a (grand)child show a higher rate of decline in memory function, and that being a victim of crime associates with slower performance on psychomotor speed tasks [11]. More so, early adversity experiences (e.g., premature loss of parents, childhood trauma or maltreatment) have been associated with the presence of general health problems, such as increased risk for dementia [45], and with higher levels of anxiety symptoms later in life [23]. Finally, an increased prevalence and incidence of depression [12] and altered brain network architecture [18] were found to be related to negative life events. In contrast, positive experiences have long been hypothesized to play an important role during major life events by, for instance, reducing reactivity to stress or by promoting faster recovery following stress exposure [9]. Middle-aged and old adults who have experienced more daily positive events have better sleep and lower levels of inflammation [36,36], and when asked to describe a memory for an event, older individuals remember and judge positive experiences as being more central to their life than the negative ones [10,4]. In fact, memories of positive events can enhance mood, and their recall may increase or maintain positive feelings that contribute to improved life satisfaction [38], and positive life events might also have a protective role against detrimental effects of negative events, restore psychological resources, and may have a buffer effect against emotional distress [4]. Still, while positive life events appear to be important modulators of health and psychological well-being, their role remains rarely studied. Here, the purpose of the present study was to investigate how both negative and positive life events associate with cognitive performance and psychological status in a cohort of well-characterized older individuals.

Methods

Participants

In collaboration with a network of 23 centres/institutions (nursing homes, social and healthcare centres) across

Braga, Guimarães and Famalicão (Northern Portugal), an in-person cognitive screening evaluation was performed on a total of 355 individuals (71.3% females; non-community and community dwellers; all caucasian) who were available on the scheduled day at each location (sample of convenience). Of these, all autonomous community-dwellers, those who did not meet exclusion criteria for the present study (inability to understand informed consent, read or write; or reported diagnosed neuropsychiatric and/or neurodegenerative disorder, cognitive impairment or dementia as provided by the institution/centers' clinical team) were further invited to undergo a comprehensive neuropsychological assessment at the Clinical Academic Center – Braga (2CA-B) (N=171, 70.8% females). From these, 68 individuals were further excluded (18 due to the presence of psychiatric, neurological and/or motor disorders, upon further evaluation; 50 due to personal unavailability, lack of interest, or COVID-19 confinement measures). A total sample of 103 individuals comprised the study cohort (age range 56 to 85 (M=70.18; SD=6.63); 77.7% female). A trained psychologist performed the neuropsychological assessments and instruments were always applied in the same order. As the battery of tests required approximately 1 h and 45 min for completion, participants were given breaks between tests when needed to minimize fatigue effects.

Of the 103 participants enrolled, 6 individuals were further excluded from data analysis due to missing data. The final sample characterisation is detailed in Table 1.

The study was approved by the local ethical committees, conducted in accordance with the Declaration of Helsinki (59th Amendment), and developed in compliance

Table 1
Sample characterization.

Sex [†]		
	Male	21 (21.6)
	Female	76 (78.4)
	Total	97 (1 0 0)
Age [‡]		70.4 ± 6.683, [56–85]
Years of formal education [‡]		5.91 ± 3.533, [0–17]
Marital status [†]		
	Married	64 (66.0)
	Widower	22 (22.7)
	Separated/divorced	7 (7.2)
	Single	2 (2.1)
	Non-marital partnership	2 (2.1)
Professional situation [†]		
	Retired	91 (93.8)
	Non-retired	6 (6.2)
Recruitment setting [†]		
	Senior Club	32 (33.0)
	Medical care center	39 (29.9)
	Parish Council	18 (18.6)
	Social Center	8 (8.2)
	Day care center	7 (7.2)
	Nursing home	3 (3.1)

Note. [†]Values are expressed as n (%); [‡] Values are expressed as mean ± SD, [range].

with the new General Data Protection Regulation. The study goals and assessments were explained to participants during screening procedures. Written informed consent was obtained from all participants before study enrolment.

Measuring instruments

Instruments were used to evaluate cognitive performance, mood, and life experiences. The cognitive instruments were chosen to accomplish a general characterization of the older individuals' cognitive profile, namely with respect to memory, attention and executive functions, domains described as being more vulnerable to the effects of aging [29]. Life events are important for the psychological functioning in later life [13], hence the use of the Geriatric Depression Scale (GDS) and the 10-item Perceived Stress Scale (PSS-10). Selected instruments are validated to the Portuguese population and were used in our previous studies [34,37].

These measures partially overlap to those of the Survey of Health, Ageing and Retirement in Europe (SHARE) study (<http://www.share-project.org>). In the SHARE study, cognitive function assessment contains subjective and objective measures of memory, concentration, numeracy and verbal fluency. With the exception of this last domain, in our study, the instruments used are also focused on overall cognition, memory, and immediate and delayed recall. Lifetime Experiences Scale (LIFES) also shares some aspects with the Retrospective Sharelife questionnaire on SHARE study, namely with childhood circumstances, health and employment history. Despite using different instruments, both evaluate the individual's mood, with the Europe-Depression Scale focusing on the last month and the GDS on the past week.

Life experiences

Contrary to most studies investigating the distribution and impact of memories of life events using predefined checklists with an established valence, here open-ended questions were performed allowing individuals to reflect on their life experiences from a lifespan perspective. Reports were collected using the Lifetime Experiences Scale validated in the Portuguese language (LIFES; [1]). This measure is composed of two sections—lived experiences and non-lived (but desired) experiences—and is available in male and female versions regarding pregnancy history. The lived experiences section comprises 75 items organized in 8 domains: School, Work, Health, Leisure, Life conditions, Adverse experiences, Achievements, and People and relationships. Individuals are asked about experiences' occurrence (yes/no), developmental stage (childhood, adolescence, and adulthood), valence (positive, negative, and neutral), and their impact (5-point Likert scale: 0—"Not at all" to 4—"Absolutely"). Following Azevedo and colleagues [2], in that combining valence and impact generates the most informative score, the total positive lived experiences were obtained by cumulatively counting the experiences with valence rated as positive, and impact-rated as some, quite or absolutely, in all developmental

stages. Both the total negative lived experiences and the total neutral lived experiences were obtained following the same procedure. The sum of these totals provides the total of lived experiences. Regarding non-lived experiences, participants are asked to indicate if they hadn't had any non-lived experience that was greatly desired. Only 3% of the total sample answered positively; thus, this aspect will not be further considered in data analysis.

Depressive mood

Depressive symptoms were assessed via the Geriatric Depression Scale (GDS; [3]), which consists of 30 dichotomous yes/no questions. Scores range from 0 to 30, with higher scores indicating more depressive symptomatology. Interpretative guidelines are as follows: scores ranging from 0 to 10 indicate normal mood, 11 to 20 indicate mild depressive symptoms and 20 to 30 indicate severe depression. The GDS normative values suggest that the identification of 11 or more symptoms constitute a criterion for the identification of depressive disorder among older individuals [31].

Perceived stress

Global perceived stress was measured with the 10-item Perceived Stress Scale (PSS-10; [41]), which assesses how frequently in the last month individuals felt stressed, overloaded, or out of control. Each item is rated on a 5-point frequency scale, ranging from "never" (0) to "very often" (4). A total PSS score is obtained by reversing the scoring of 4 positive items and then summing across all 10 items with higher scores indicating higher perceived stress. Trigo and colleagues [41] established that scores above the 80th percentile are indicators of pathology. The cut-off values for pathological scores on the PSS-10 are 20 for men and 22 for women.

Cognitive functioning

Attention was assessed with the Digit Span forward test and working memory with the Digit Span backward from the Wechsler Adult Intelligence Scale, 3rd edition [46]; executive function and processing speed with the Digit Symbol Substitution test (DSST) from the Wechsler Adult Intelligence Scale, 3rd edition [46]; global cognitive functioning was evaluated with the Montreal Cognitive Assessment (MOCA; [15], and learning and memory storage, retention and retrieval with the Buschke Selective Reminding Test (SRT; [17,16]). SRT uses a multiple-trial list-learning task from which separate scores are derived, as long-term storage, consistent long-term and delayed recall.

Data analyses

All descriptive and inferential analyses were performed using the IBM Statistical Package of Social Sciences Software (IBM SPSS; version 26.0 for windows). Because the assumptions of parametric data were not met, namely normality, non-parametric difference tests were performed to compare groups: Mann-Whitney tests were used to test

differences between two groups (i.e., related to sex and professional status), and Kruskal-Wallis tests were applied when more than two groups were compared (i.e., age, marital status, and education). To clarify the differences obtained by Kruskal-Wallis analyses, Mann-Whitney tests were used and based on a Bonferroni correction, all effects were tested at a 0.017 level of significance. Similarly, Spearman's nonparametric test was used to compute correlations between LIFES lived experiences (positive and negative experiences) and psychological and cognitive measures; and LIFES specific domains (school, work, health, leisure, life conditions, adverse experiences, achievements, and people and relationships) and psychological and cognitive measures. Correlation analysis between LIFES lived experiences and cognitive measures were then followed by hierarchical multiple regressions to control for covariates, using the enter method. This analysis was performed to examine the contribution of age (in years), sex, years of schooling, mood (as measured by the GDS) and lived experiences as influencing factors on cognitive tests performance. The first block included sex, age, school years and mood, and the second block consisted of lived experiences. Separate models were run for each cognitive test. The level of statistical significance was set at $p < 0.05$ (2-tailed).

Results

Positive and negative life events assessment

Descriptive statistics for LIFES Experiences (Positive, Negative, Neutral, and Total) and the cognitive and psychological tests are provided in Supplementary Table 1. The number of total experiences reported ranged from 4 to 69 ($M = 31.57$, $SD = 14.27$). The most-reported experiences by the participants were: "I have some work experience", "I had some leisure time, having fun with my friends/col-

leagues", and "I changed residences". In turn, "I was involved in a crime," and "I was arrested" and "I was forced to leave my family" were the least reported experiences. A total of 95.9% of the participants reported more positive life experiences than negative ones. The mean of positive experiences was 25.9, whereas the mean negative experiences was 4.70 (Supplementary Table 1).

As seen in Table 2, lived experiences did not differ based on sex or marital status, but they were significantly affected by school education, age and professional status. To elucidate these differences, Mann-Whitney analyses were performed, applying a Bonferroni correction. Regarding school education, participants with more than 10 years of schooling reported more life experiences compared to those with up to 3 years of education ($p = .001$), and more positive experiences compared to those with up to 3 ($p = .001$) and 4 to 9 ($p = .009$) years of education. Individuals with 4 to 9 school years presented more life experiences ($p = .012$) and more positive experiences ($p = .016$) compared to those with up to 3 years of schooling. Concerning age, individuals between 65 and 74 reported more negative experiences than those between 75 and 85 years ($p = .014$) with no other differences in other group comparisons. Lastly, retirement significantly impacted in the total of lived experiences, with non-retired individuals reporting more lived experiences ($p = .007$). Full results of Mann-Whitney analyses are summarized in Table 2.

At the domain-level of the LIFES questionnaire, males reported more positive experiences compared to females at Job ($p = .001$) and Life conditions ($p = .001$) and females reported significantly more negative experiences at personal relationships ($p = .002$).

Life events and psychological morbidity

Most participants presented normal GDS scores, while 43.3% showed mildly depression and 7.2% severe depres-

Table 2
Difference Tests, Mean Ranks, and Median for Lived Experiences, by Sex, Age, Marital Status, Years of Education and Professional Status.

Lived experiences			
Groups (n)	Total Mean rank (Median)	Positive Mean rank (Median)	Negative Mean rank (Median)
Sex	$U = 687.5$, $z = -0.96$, $p = .333$	$U = 619.0$, $z = -1.57$, $p = .117$	$U = 581.5$, $z = -1.91$, $p = .056$
Males (21)	54.2 (34)	57.5 (30)	38.6 (3)
Females (76)	47.5 (30)	46.6 (24)	51.85 (4)
Age	$H(2) = 1.55$, $p = .459$	$H(2) = 0.61$, $p = .735$	$H(2) = 8.81$, $p < .012$
55–64 (18)	49.28 (36)	49.97 (23.5)	38.19 (2.5)
65–74 (52)	51.78 (34)	50.53 (28.5)	56.79 (5)
75–85 (27)	43.46 (29)	45.41 (23)	41.20 (3)
Marital status	$H(4) = 4.08$, $p = .395$	$H(4) = 6.44$, $p = .168$	$H(4) = 4.08$, $p = .395$
Married (64)	51.85 (35)	53.21 (29)	46.32 (4)
Widower (22)	38.07 (24.5)	36.18 (19.5)	49.09 (3.5)
Separated (7)	48.86 (29)	48.93 (23)	58.93 (5)
Single (2)	52.50 (33.5)	45.25 (25.5)	74.50 (6.5)
Non-marital partnership (2)	52.50 (32)	37.50 (22.5)	48.25 (6.5)
Years of education	$H(2) = 12.51$, $p < .002$	$H(2) = 14.50$, $p < .001$	$H(2) = 1.01$, $p = .601$
0–3 (15)	29.83 (23)	30.13 (21)	43.47 (3)
4–9 (69)	49.72 (32)	49.01 (26)	50.78 (4)
greater than 10 (13)	57.31 (39)	70.73 (37)	45.96 (3)
Professional status	$U = 92.00$, $z = -2.71$, $p < .007$	$U = 140.50$, $z = -1.98$, $p = .047$	$U = 172.00$, $z = -1.52$, $p = .128$
Retired (91)	47.01 (31)	47.54 (25)	47.89 (4)
Non-Retired (6)	79.17 (45.5)	71.08 (38)	65.83 (7)

sive symptoms. Concerning the PSS-10, the overall score averaged 8.71 (SD = 5.497) for men and 13.03 (SD = 6.849) for women. Only one male participant (4.8%) had a score above 20, while 10.5% of females scored above 22.

The total of positive life experiences was negatively correlated with depressive mood and perceived stress (Fig. 1; see Supplementary Table 2). In turn, the total of negative life experiences was positively correlated with the GDS measure, indicating that individuals with a higher number of negative lived events showed higher levels of depressive mood. At the domain-level of LIFES questionnaire, more reported negative experiences in the Job domain were correlated with a depressed mood ($r_s = 0.21$, $p < .05$). Experiencing more negative events in the Health domain was related to a higher depressive mood ($r_s = 0.25$, $p < .01$) and perceived stress ($r_s = 0.33$, $p < .01$) (Table 3). Interestingly, positive experiences in the social participation or Leisure domain were negatively correlated with the GDS measure, indicating that participants with more positive reported experiences in this domain had lower depressive symptoms ($r_s = -0.21$, $p < .01$).

Life events and cognition

Significant positive correlations were found between positive life experiences and most cognitive measures, indicating that participants who reported a higher number of positive experiences also presented higher scores on the cognitive tests (Fig. 2; Supplementary Table 2). Hierarchical multiple regressions were then conducted independently for all cognitive measures as dependent variables (Table 4). The regression models (first block comprised sex, age, school years and mood, and the second block consisted of positive experiences) were both significant for all cognitive tests. Model 2, with the addition of positive experiences, was an improvement over the earlier model. The results of the regression indicated that this model explained between 63% – 17% of the cognitive tests variance. Specifically, positive experiences had significant positive regression weights in MOCA, SRT LTS, Digits Forward and DSST tests, indicating that individuals with more positive experiences have a higher performance in these cognitive tests, after controlling for the other variables. Moreover, school education was the constant significant

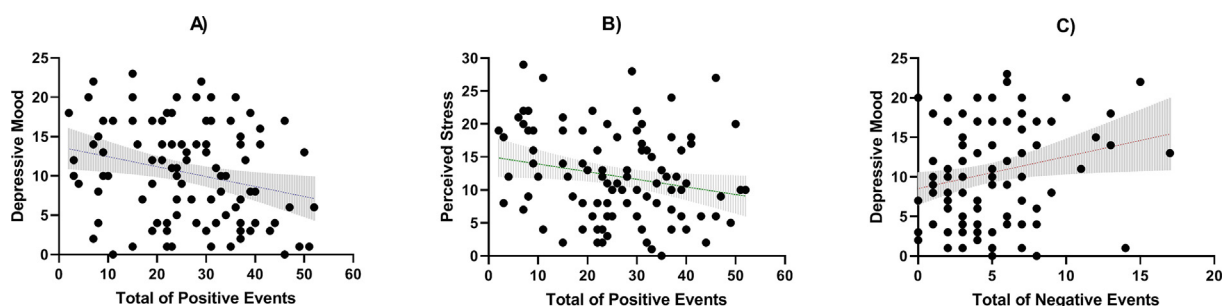


Fig. 1. Scatterplots showing relationships between A) total positive life events and depressive mood (Spearman's $r_s = -0.24$), B) total positive life events and perceived stress (Spearman's $r_s = -0.20$), and C) the association between total negative events and depressive mood (Spearman's $r_s = 0.22$). Level of statistical significance set at $p < .05$.

Table 3

Spearman's Correlations Between LIFES specific domains and psychological and cognitive tests.

LIFES Domains		PSS	GDS	MOCA	SRT LTS	SRT CLTR	SRT DR	Digits forward	Digits backward	DSST
School	P	-0.10	-0.12	0.45**	0.44**	0.43**	0.33**	0.25*	0.21*	0.36**
	N	-0.01	-0.06	0.35**	0.16	0.16	0.12	0.11	0.23*	0.24*
Work	P	-0.06	-0.05	0.30**	0.26**	0.24*	0.20*	0.22*	0.08	0.20*
	N	0.10	0.21*	0.11	0.17	0.10	0.11	0.03	0.04	0.05
Health	P	-0.22*	-0.20*	0.43**	0.35**	0.32**	0.25*	0.36**	0.12	0.41**
	N	0.33**	0.25*	0.09	0.03	-0.02	-0.19	0.11	0.08	0.02
Leisure	P	-0.17	-0.21*	0.34**	0.33**	0.27**	0.17	0.33**	0.12	0.29**
	N	-0.18	-0.19	0.36**	0.38**	0.19	0.32**	0.32**	0.16	0.26**
Life Conditions	P	-0.18	-0.19	0.36**	0.38**	0.19	0.32**	0.32**	0.16	0.26**
	N	0.11	0.05	-0.02	-0.01	0.01	-0.14	0.03	0.08	-0.05
Adverse Experiences	P	0.11	0.04	-0.06	0.03	0.03	-0.07	-0.13	0.03	0.00
	N	-0.18	-0.16	0.22*	0.24*	0.22*	0.13	0.18	0.13	0.20*
Achievements	P	-0.10	-0.15	0.32**	0.17	0.10	0.10	0.29**	0.03	0.25*
	N	0.10	0.14	0.04	0.08	0.13	-0.03	-0.02	0.12	0.03
People and Relationships	P	-0.10	-0.15	0.32**	0.17	0.10	0.10	0.29**	0.03	0.25*
	N	0.10	0.14	0.04	0.08	0.13	-0.03	-0.02	0.12	0.03

Note. P, Positive Experiences ; N, Negative Experiences ; GDS, Geriatric Depression Scale; PSS, Perceived Stress Scale; MoCA, The Montreal Cognitive Assessment; SRT LTS, Selective Reminding Test Long-Term Storage; SRT CLTR, Selective Reminding Test Consistent Long-Term Recall; SRT DR, Selective Reminding test Delayed Recall; DSST, Digit Symbol Substitution Test.

* $p < .05$. ** $p < .01$.

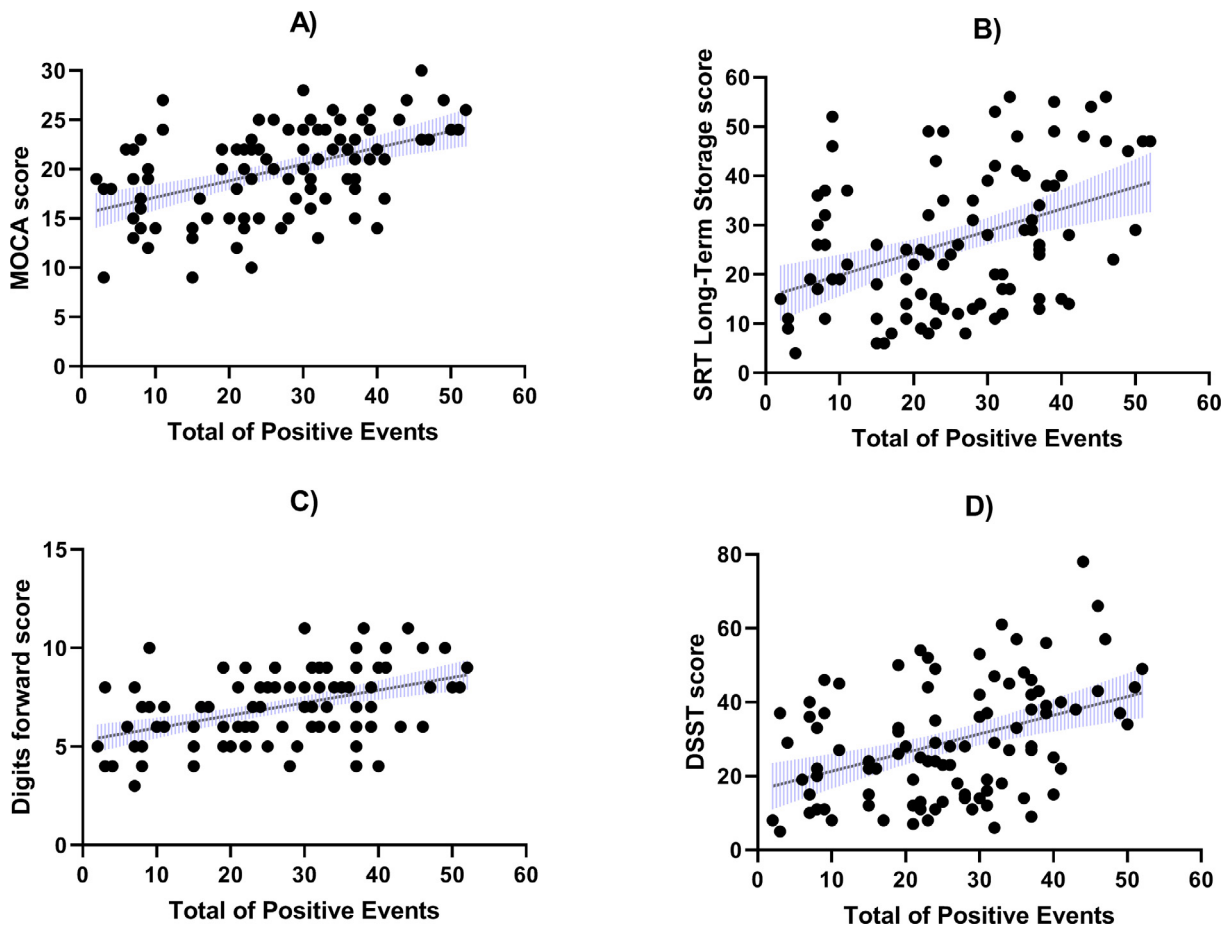


Fig. 2. Illustrating associations between total positive events and several cognitive tests. The scatterplots depict that participants who reported more positive events had higher scores on A) global cognition (Spearman's $r_s = 0.46$), B) memory storage (Spearman's $r_s = 0.40$), C) attention (Spearman's $r_s = 0.42$), and D) speed of processing (Spearman's $r_s = 0.39$). Level of statistical significance set at $p < .05$. *Note.* MoCA, The Montreal Cognitive Assessment; SRT LTS, Selective Reminding Test Long-Term Storage; DSST, Digit Symbol Substitution Test.

predictor in the two models (Table 4). Results indicated that more years of education (formal school years) was a significant predictor for increased total scores in all cognitive tests and its effect remained significant when including positive experiences in the second block. Age emerged as an influencing factor in both models for MOCA, SRT test in its various components and the DSST test (Table 4), indicating lower test performance with increasing age. Mood was a significant predictor only in the DSST test scores in both models ($p < .01$), even when mediated by positive experiences. Finally, sex was not significant in any model, meaning that this variable was not relevant in explaining cognitive performance in the cohort.

As no significant correlations were observed between negative life events and the cognitive measures, hierarchical multiple regressions were not performed.

At the domain level, positive experiences on School and Work domains were positively correlated with MOCA test, SRT long-term storage, SRT consistent long-term, SRT delayed recall, Digits Forward, and Digit Symbol Substitution Test (statistics in Table 3). Significant correlations were also found between positive experiences in the

Health domain and most cognitive measures, indicating that older adults experiencing more positive events in Health had a higher cognitive performance. Only positive experiences were reported in the Leisure domain, thus Spearman's rho revealed significant correlations between positive experiences and cognitive tests evaluating for global cognition, attention, working memory, and processing speed (Table 3). Positive events in the Life Conditions and Accomplishments domains were positively correlated with most cognitive tests results (Table 3). Regarding Personal Relationships, positive experiences were positively correlated with global cognition ($r_s = 0.32$, $p < .01$), processing speed ($r_s = 0.25$, $p < .05$) and attention ($r_s = 0.29$, $p < .01$) measures (Table 3). Ultimately, concerning the adverse experiences domain, no significant correlations emerged between negative/positive events and cognitive and psychological measures.

Discussion

In this study, we examined both positive and negative life events on cognitive functioning and psychological sta-

Table 4
Hierarchical multiple regression for variables predicting cognitive performance.

Predictors	MOCA			SRT LTS			SRT CLTR			SRT DR			Digits forward			Digits backward			DSST		
	B	β	t	B	β	t	B	β	t	B	β	t	B	β	t	B	β	t	B	β	t
Model 1																					
Sex	-1.29	-0.12	-1.48	1.56	0.05	0.50	1.09	0.04	0.42	0.32	0.05	0.49	-0.52	-0.11	-1.19	-0.36	-0.07	-0.74	-0.37	-0.01	-0.15
Age	-0.23	-0.33	-4.06***	-0.51	-0.24	-2.58**	-0.39	-0.23	-2.44*	-0.10	-0.24	-2.59**	-0.05	-0.16	-1.62	-0.04	-0.13	-1.26	-1.11	-0.47	-6.83***
School years	0.56	0.44	5.08***	1.58	0.39	4.04***	1.43	0.43	4.42***	0.30	0.37	3.74**	0.21	0.38	3.72***	0.19	0.33	3.12**	1.93	0.43	5.99***
Mood	-0.09	-0.11	-1.4	-0.12	-0.05	-0.58	-0.07	-0.04	-0.42	-0.06	-0.13	-1.41	-0.01	-0.02	-0.23	-0.01	-0.04	-0.40	-0.56	-0.22	-3.20**
R² (R_{adj}); F(df1;df2); p	0.45 (0.43); F(4,91)			0.28 (0.25); F(4,92)			0.30 (0.27); F(4,92)			0.28 (0.25); F(4,92)			0.23 (0.20); F(4,92)			0.17 (0.14); F(4,92)			0.62 (0.60); F(4,92)		
	= 19.04***			= 8.99***			= 9.77***			= 9.10***			= 6.99***			= 4.75**			= 36.74***		
Model 2																					
Sex	-1.17	-0.11	-1.39	1.97	0.06	0.66	1.32	0.05	0.52	0.33	0.05	0.51	-0.47	-0.1	-1.09	-0.35	-0.07	-0.72	-0.12	0.00	-0.05
Age	-0.22	-0.32	-4.11***	-0.49	-0.23	-2.55**	-0.39	-0.22	-2.39*	-0.10	-0.24	-2.56**	-0.04	-0.15	-1.56	-0.04	-0.13	-1.25	-1.09	-0.46	-6.85***
School years	0.451	0.35	4.05***	1.23	0.31	3.09***	1.24	0.37	3.67***	0.29	0.36	3.43***	0.16	0.29	2.84**	0.19	0.32	2.88**	1.71	0.38	5.14***
Mood	-0.06	-0.08	-0.99	-0.03	-0.02	-0.17	-0.02	-0.01	-0.14	-0.06	-0.13	-1.34	0.04	0.01	0.15	-0.01	-0.04	-0.36	-0.50	-0.20	-2.89**
Positive Experiences	0.09	0.25	3.06**	0.28	0.25	2.67**	0.16	0.17	1.79	0.01	0.03	0.31	0.04	0.24	2.42*	0.03	0.02	0.18	0.17	0.14	1.98*
R² (R_{adj}); F(df1;df2); p	0.51 (0.48); F(5,95)			0.33 (0.30); F(5,91)			0.32 (0.29); F(5,91)			0.28 (0.24); F(5,91)			0.28 (0.24); F(5,91)			0.17 (0.13); F(5,91)			0.63 (0.61); F(5,91)		
	= 18.49***			= 9.10***			= 8.64***			= 7.19***			= 7.07***			= 3.76**			= 31.17***		

Note. GDS, Geriatric Depression Scale; PSS, Perceived Stress Scale; MoCA, The Montreal Cognitive Assessment; SRT LTS, Selective Reminding Test Long-Term Storage; SRT CLTR, Selective Reminding Test Consistent Long-Term Recall; SRT DR, Selective Reminding test Delayed Recall; DSST, Digit Symbol Substitution Test.

* $p < .05$. ** $p < .01$. *** $p < .001$.

tus in a sample of community-dwelling older individuals. Briefly, participants who reported more positive experiences had lower scores in the depressive mood and perceived stress measures. Personal relationships were positively associated with a better cognitive performance in almost all cognitive tests. These findings are in agreement with previous studies showing that positive interactions benefit memory and executive function, and that greater levels of social support (satisfactory social network and engaging in diverse social activities), play a crucial role in the maintenance of cognitive functions in older age [19,27]. Notably, in our study, 67% of all participants reported participating in diverse activities that promote healthy behaviours, mental stimulation, and rich social activities. Such leisure activities impact physical and mental health, and facilitate a greater cognitive reserve [35]. In fact, cognitive reserve model states that individuals with a more flexible or effective neural network have a superior ability to intersperse cognitive strategies to overcome more easily the challenges and demands that are presented to them [40]. A robust cognitive reserve capacity allows individuals to remain resilient, able to confront and deal with life events, and increases brain adaptability in the presence of geriatric depression. Furthermore, studies have shown that cognitive reserve is associated with a high level of cognitive performance [24] suggesting that individuals with greater cognitive reserve may have more resources to confront cognitive decline.

Cognition is known to be affected by several factors with an impact on aging, such as years of education and mood state [34,7], and to affect different biological systems in humans [14]. On the particular role of education, our findings indicate that it associates with reporting lived experiences. Specifically, participants with more reported lived experiences and, in particular, more positive events, also had more years of education. Having a longer educational background has been consistently related to subjective well-being, better cognitive performance, and more positive psychological states [30]. Moreover, education has been considered an early life foundation resource that facilitates access to multiple types of other resources across adulthood, shaping people's social relationships, social roles, and level of activities [30].

Here, we also observed a positivity effect phenomenon, meaning that older adults seem to favor positive memories, remember events more positively, and focus on information that is likely to support a positive emotional state and enhance wellbeing [43]. Events also can signify accomplishments, developmental milestones, and changes for the better in living conditions. In fact, recent research indicates that older individuals remember and judge positive experiences as being more central to their life than negative ones [10,4]. In the present study, positive associations were observed between more positive experiences in Accomplishments, Work and Living Conditions domains of LIFES and most cognitive tests. Previous studies suggest that a good living environment is an important source of cognitive stimuli [6], and that employment is a protective indicator of cognitive functioning in older adults [42]. Occupation requires learning new skills, establishing a routine and social involvement, which bolsters cognitive

reserve. However, this is true for occupations that have a purpose and meaning attached to them, once it has been demonstrated excessive stressful work has negative impacts on cognition [30] and is associated with an elevated risk for mental disorders, including depression [25].

Paradoxically, positive associations were observed between more negative life events in the School domain of LIFES with three cognitive tests evaluating for global cognition, working memory, and speed of processing. These results may be explained by coping mechanisms that individuals used to react to the negative events and to protect themselves from their effects, specifically problem-focused coping. Literature has also shown the importance of cognitive function as a resource for coping with stress, individuals must possess a reasonable level of cognitive functioning, to plan alternative strategies and then implement the most promising ones [22,5]. In this context, it is important to refer that previous studies indicate that when dealing with stressful events, women and men often differ in their coping strategies [26,33]. Older women have a more emotional-oriented response and support-seeking, whereas older men focus on a problem-directed adaptation [26,33].

Literature on negative life events and their long-term consequences on well-being is extensive (for review see [21]). For instance, it has been shown that the most frequent negative and stressful life circumstances that confront older individuals involve physical and mental health issues and work-related events [28]. In our sample, we observed that more negative experiences in Health and Work domains of LIFES were associated with a higher depressive mood. The Work domain includes unemployment, retirement, and promotion experiences. In our sample, 31% of participants have already been unemployed at some point in their lives and 19% reported that the retirement transition was a negative experience. It has been shown that retirement is a major life event *per se*, with controversy surrounding its impact on mental health and cognition [20,8]. For instance, empirical evidence shows that retirement improves cognition in the short-run and is detrimental in the long-run, and it may even have a different impact for individuals at the statutory retirement eligibility age and for those who retire as soon as possible [8]. In this study, when analysed for possible differences between the two sexes, we observed that males reported more positive experiences compared to females at the Work domain. This may be explained due to the fact that at later ages women had likely less access to opportunities of employment and they retired earlier than men. Many older women still depend on their husband's salary or survivor pension for a decent standard of living [44]. Thus, our results should be interpreted with caution. Other factors should be considered in the association found between the accumulation of negative experiences throughout life and the presence of depressive symptomatology, namely psychological, biological and social attributes [12].

The findings of the present study must be interpreted considering several limitations. Firstly, as it relates to the measure itself. In life events research, it is postulated that any life events scale, regardless of its length, contains only a subset of situations that can occur in one's life and the

LIFES questionnaire is not as an exception. Besides, LIFES can be also influenced by other variables such as participants' mood and willingness to respond. In fact, from our initial sample composed of 103 individuals, 6 of them did not complete the LIFES protocol because they found it very exhausting and/or long. It is impossible to infer if others finalized in already a state of tiredness and how much that impacts how they answer. Furthermore, our study relied on a small convenience sample composed predominantly by females, this may be the reason for the lack of sex differences observed in the majority of the analyses. No causal inferences can be derived, and findings may not be representative of a larger population. Finally, in future studies, other factors should be taken into consideration (for example, personality traits).

Despite its limitations, the study adds important evidence on the impact of positive experiences on cognition and psychological well-being, thus contributing to a balance in the literature so far characterized by a long tradition of published studies on negative/traumatic life events. Moreover, it presents valuable evidence that support the need for the integration of mental well-being strategies as a core outcome of psychological treatment, and as a resource in the prevention and treatment of psychological conditions such as anxiety, depression and stress-related problems. Recalling positive memories prime individuals to focus on good feelings, change views of other events, and provide coping strategies to overcome stress resulting from negative events. Research addressing these topics should be encouraged to design appropriate interventions on psychological well-being for older adults.

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CRedit authorship contribution statement

T.C. Castanho: Conceptualization, Formal analysis, Data curation, Investigation, Methodology, Supervision, Writing – original draft, Writing – review & editing. **N.C. Santos:** Conceptualization, Formal analysis, Investigation, Methodology, Project administration, Supervision, Writing – origi-

nal draft, Writing - review & editing. **C. Meleiro-Neves:** Formal analysis, Investigation, Data curation. **S. Neto:** Investigation, Methodology, Writing - review & editing. **G.R. Moura:** Investigation, Methodology, Writing - review & editing. **M.A. Santos:** Investigation, Methodology, Writing - review & editing. **A.R. Cruz:** Investigation, Writing - review & editing. **O. Cunha:** Methodology, Writing - review & editing. **A. Castro Rodrigues:** Methodology, Writing - review & editing. **A.J. Rodrigues:** Conceptualization, Funding acquisition, Investigation, Methodology, Project administration, Resources, Supervision, Writing - original draft, Writing - review & editing. **N. Sousa:** Conceptualization, Funding acquisition, Investigation, Methodology, Project administration, Resources, Supervision, Writing - original draft, Writing - review & editing.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.nbas.2021.100020>.

References

- [1] V. Azevedo, C. Martins, Â. Maia, Life experiences throughout the lifespan: what do people say (or Not) about them?, *J Adult Dev* 25 (2) (2018) 69–85, <https://doi.org/10.1007/s10804-017-9277-6>.
- [2] V. Azevedo, C. Martins, Â. Maia, Lifetime experiences scale (LIFES): development and validation in community samples, *Psicologia* 34 (1) (2020) 174–194.
- [3] Barreto, J., Leuschner, A., Santos, F., & Sobral, M. (2003). Escala de queixas de memória. In *Escalas e testes na demência*, Grupo de estudos de envelhecimento cerebral e demências. GEECD: Lisboa.
- [4] D. Berntsen, D.C. Rubin, I.C. Siegler, Two versions of life: emotionally negative and positive life events have different roles in the organization of life story and identity, *Emotion* 11 (5) (2011) 1190–1201, <https://doi.org/10.1037/a0024940>.
- [5] J. Cairney, N. Krause, Negative life events and age-related decline in mastery: are older adults more vulnerable to the control-eroding effect of stress?, *J Gerontol Ser B* 63 (3) (2008) S162–S170, <https://doi.org/10.1093/geronb/63.3.S162>.
- [6] M. Cassarino, A. Setti, Environment as 'Brain Training': a review of geographical and physical environmental influences on cognitive ageing, *Ageing Res Rev* 23 (2015) 167–182, <https://doi.org/10.1016/j.arr.2015.06.003>.
- [7] T.C. Castanho, P.S. Moreira, C. Portugal-Nunes, A. Novais, P.S. Costa, J. A. Palha, et al., The role of sex and sex-related hormones in cognition, mood and well-being in older men and women, *Biol Psychol* 103 (2014) 158–166, <https://doi.org/10.1016/j.biopsycho.2014.08.015>.
- [8] M. Celidoni, C. Dal Bianco, G. Weber, Retirement and cognitive decline. A longitudinal analysis using SHARE data, *J Health Econ* 56 (2017) 113–125, <https://doi.org/10.1016/j.jhealeco.2017.09.003>.
- [9] S. Cohen, H.M. Hoberman, Positive events and social supports as buffers of life change stress1, *J Appl Soc Psychol* 13 (2) (1983) 99–125, <https://doi.org/10.1111/jasp.1983.13.issue-210.1111/j.1559-1816.1983.tb02325.x>.
- [10] C. Comblain, A. D'Argembeau, M. Van der Linden, Phenomenal characteristics of autobiographical memories for emotional and neutral events in older and younger adults, *Exp Aging Res* 31 (2) (2005) 173–189, <https://doi.org/10.1080/03610730590915010>.
- [11] H.C. Comijs, T.N. van den Kommer, R.W.M. Minnaar, B.W.J.H. Penninx, D.J.H. Deeg, Accumulated and differential effects of life events on cognitive decline in older persons: depending on depression, baseline cognition, or ApoE ε4 Status?, *J Gerontol Ser B* 66B (suppl_1) (2011) i111–i120, <https://doi.org/10.1093/geronb/gbr019>.
- [12] J. Falkingham, M. Evandrou, M. Qin, A. Vlachantoni, Accumulated lifecourse adversities and depressive symptoms in later life among older men and women in England: a longitudinal study, *Ageing and Society* 40 (10) (2020) 2079–2105, <https://doi.org/10.1017/s0144686x19000461>.
- [13] Filho, W. L., Wall, T., Azul, A. M., Brandli, L., Özuyar, P.G. (Eds.). (2020). Good health and well-being. Springer Nature Switzerland AG.
- [14] Patrícia Fino, Rita Matos Sousa, Renata Carvalho, Nuno Sousa, Filipa Almeida, Vítor Hugo Pereira, Cognitive performance is associated with worse prognosis in patients with heart failure with reduced ejection fraction, *ESC Heart Failure* 7 (5) (2020) 3059–3066, <https://doi.org/10.1002/ehf2.v7.510.1002/ehf2.12932>.
- [15] S. Freitas, M.R. Simões, J. Marôco, L. Alves, I. Santana, Construct validity of the montreal cognitive assessment (MoCA), *J Int Neuropsychol Soc* 18 (2) (2012) 242–250, <https://doi.org/10.1017/s1355617711001573>.
- [16] E. Grober, A.E. Sanders, C. Hall, R.B. Lipton, Free and cued selective reminding identifies very mild dementia in primary care, *Alzheimer Dis Assoc Disord* 24 (3) (2010) 284–290, <https://doi.org/10.1097/WAD.0b013e3181cfc78b>.
- [17] E. Grober, A. Merling, T. Heimlich, R.B. Lipton, Free and cued selective reminding and selective reminding in the elderly, *J Clin Exp Neuropsychol* 19 (5) (1997) 643–654, <https://doi.org/10.1080/01688639708403750>.
- [18] Arpana Gupta, Emeran A. Mayer, Jonathan R. Acosta, Kareem Hamadani, Carinna Torgerson, John D. van Horn, et al., Early adverse life events are associated with altered brain network architecture in a sex- dependent manner, *Neurobiol Stress* 7 (2017) 16–26, <https://doi.org/10.1016/j.yynstr.2017.02.003>.
- [19] M.E. Kelly, H. Duff, S. Kelly, J.E. McHugh Power, S. Brennan, B.A. Lawlor, et al., The impact of social activities, social networks, social support and social relationships on the cognitive functioning of healthy older adults: a systematic review, *Systemat Rev* 6 (1) (2017) 259, <https://doi.org/10.1186/s13643-017-0632-2>.
- [20] J.E. Kim, P. Moen, Retirement transitions, gender, and psychological well-being: a life-course, ecological model, *J Gerontol Ser B* 57 (3) (2002) P212–P222, <https://doi.org/10.1093/geronb/57.3.P212>.
- [21] V. Kraaij, E. Arensman, P. Spinhoven, Negative life events and depression in elderly persons: a meta-analysis, *J Gerontol Ser B* 57 (1) (2002) P87–P94, <https://doi.org/10.1093/geronb/57.1.P87>.
- [22] N. Krause, Stress, gender, cognitive impairment, and outpatient physician use in later life, *J Gerontol Ser B* 51B (1) (1996) 15–23, <https://doi.org/10.1093/geronb/51B.1.P15>.
- [23] Anna Lähdepuro, Katrin Savolainen, Marius Lahti-Pulkkinen, Johan G. Eriksson, Jari Lahti, Soile Tuovinen, et al., The impact of early life stress on anxiety symptoms in late adulthood, *Sci Rep* 9 (1) (2019), <https://doi.org/10.1038/s41598-019-40698-0>.
- [24] C. Lojo-Seoane, D. Facal, J. Guàrdia-Olmos, A.X. Pereiro, O. Juncos-Rabadán, Effects of cognitive reserve on cognitive performance in a follow-up study in older adults with subjective cognitive complaints. The role of working memory, *Front Aging Neurosci* 10 (2018) 189, <https://doi.org/10.3389/fnagi.2018.00189>.
- [25] T. Lunau, M. Warendorf, N. Dragano, J. Siegrist, Work stress and depressive symptoms in older employees: impact of national labour and social policies, *BMC Public Health* 13 (2013) 1086, <https://doi.org/10.1186/1471-2458-13-1086>.
- [26] J.C. Meléndez, T. Mayordomo, P. Sancho, J.M. Tomás, Coping strategies: gender differences and development throughout life span, *Span J Psychol* 15 (3) (2012) 1089–1098, https://doi.org/10.5209/rev_sjop.2012.v15.n3.39399.
- [27] S. Miceli, L. Maniscalco, D. Matranga, Social networks and social activities promote cognitive functioning in both concurrent and prospective time: evidence from the SHARE survey, *Eur J Ageing* 16 (2) (2018) 145–154, <https://doi.org/10.1007/s10433-018-0486-z>.
- [28] R.H. Moos, P.L. Brennan, K.K. Schutte, B.S. Moos, Older adults' coping with negative life events: common processes of managing health, interpersonal, and financial/work stressors, *Int J Aging Hum Dev* 62 (1) (2006) 39–59, <https://doi.org/10.2190/ENLH-WAA2-AX8J-WRT1>.

- [29] Daniel Murman, The impact of age on cognition, *Semin Hearing* 36 (03) (2015) 111–121, <https://doi.org/10.1055/s-0000006710.1055/s-005-2947310.1055/s-0035-1555115>.
- [30] S.A. Murrell, N.L. Salsman, S. Meeks, Educational attainment, positive psychological mediators, and resources for health and vitality in older adults, *J Aging Health* 15 (4) (2003) 591–615, <https://doi.org/10.1177/0898264303256198>.
- [31] Margarida T.S. Pocinho, Carlos Farate, Carlos A. Dias, Tina T. Lee, Jerome A. Yesavage, Clinical and psychometric validation of the geriatric depression scale (GDS) for Portuguese elders, *Clin Gerontol* 32 (2) (2009) 223–236, <https://doi.org/10.1080/07317110802678680>.
- [32] C.D. Ryff, Happiness is everything, or is it? Explorations on the meaning of psychological well-being, *J Pers Soc Psychol* 57 (6) (1989) 1069–1081, <https://doi.org/10.1037/0022-3514.57.6.1069>.
- [33] L. Rubio, C. Dumitrache, E. Cordon-Pozo, R. Rubio-Herrera, Coping: impact of gender and stressful life events in middle and in old age, *Clin Gerontol* 39 (5) (2016) 468–488, <https://doi.org/10.1080/07317115.2015.1132290>.
- [34] Nadine C. Santos, Patrício S. Costa, Pedro Cunha, Carlos Portugal-Nunes, Liliana Amorim, Jorge Cotter, et al., Clinical, physical and lifestyle variables and relationship with cognition and mood in aging: a cross-sectional analysis of distinct educational groups, *Front Aging Neurosci* 6 (2014), <https://doi.org/10.3389/fnagi.2014.00021>.
- [35] N. Scarmeas, Y. Stern, Cognitive reserve and lifestyle, *J Clin Exp Neuropsychol* 25 (5) (2003) 625–633, <https://doi.org/10.1076/jcen.25.5.625.14576>.
- [36] N.L. Sin, D.M. Almeida, T.L. Crain, E.E. Kossek, L.F. Berkman, O.M. Buxton, Bidirectional, temporal associations of sleep with positive events, affect, and stressors in daily life across a week, *Ann Behav Med A Publ Soc Behav Med* 51 (3) (2017) 402–415, <https://doi.org/10.1007/s12160-016-9864-y>.
- [37] J.M. Soares, P. Marques, R. Magalhães, N.C. Santos, N. Sousa, The association between stress and mood across the adult lifespan on default mode network, *Brain Struct Funct* 222 (1) (2017) 101–112, <https://doi.org/10.1007/s00429-016-1203-3>.
- [38] Megan E. Speer, Jamil P. Bhanji, Mauricio R. Delgado, Savoring the past: positive memories evoke value representations in the striatum, *Neuron* 84 (4) (2014) 847–856, <https://doi.org/10.1016/j.neuron.2014.09.028>.
- [39] M.C. Stallings, C.C. Dunham, M. Gatz, L.A. Baker, V.L. Bengtson, Relationships among life events and psychological well-being: more evidence for a two-factor theory of well-being, *J Appl Gerontol* 16 (1) (1997) 104–119, <https://doi.org/10.1177/073346489701600106>.
- [40] Y. Stern, C.A. Barnes, C. Grady, R.N. Jones, N. Raz, Brain reserve, cognitive reserve, compensation, and maintenance: operationalization, validity, and mechanisms of cognitive resilience, *Neurobiol Aging* 83 (2019) 124–129, <https://doi.org/10.1016/j.neurobiolaging.2019.03.022>.
- [41] M. Trigo, N. Canudo, F. Branco, D. Silva, Estudo das propriedades psicométricas da Perceived Stress Scale (PSS) na população portuguesa, *Psychologica* 53 (2010) 353–378, https://doi.org/10.14195/1647-8606_53_17.
- [42] D. Vance, J. Bail, C. Enah, J. Palmer, A.K. Hoenig, The impact of employment on cognition and cognitive reserve: implications across diseases and aging, *Nurs Res Rev* 6 (2016) 61–71, <https://doi.org/10.2147/NRR.S115625>.
- [43] S. Umanath, D. Berntsen, Some personal life events are more prominent than others: Younger and older adults agree on which life events matter most, *Memory Studies* 13 (4) (2018) 551–569, <https://doi.org/10.1177/1750698017754250>.
- [44] United Nations, Gender equality in ageing societies, United Nations (2020), <https://doi.org/10.18356/092a41cd-en>.
- [45] K.B. Walhovd, G.R. Howell, S.J. Ritchie, R.T. Staff, C.W. Cotman, What are the earlier life contributions to reserve and resilience?, *Neurobiol Aging* 83 (2019) 135–139, <https://doi.org/10.1016/j.neurobiolaging.2019.04.014>.
- [46] Wechsler, D. (2008). Wechsler adult intelligence scale (3rd ed. Manual). Lisbon, Portugal: CEGOC-TEA.